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By

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Abstract
This study was undertaken to describe the role played by Indigenous Knowledge (IK) (Traditional Ecological Knowledge (TEK) and Traditional Knowledge (TK)) of the local community farmers in Lindi and Mtwara regions and determine their overall perceptions on usefulness of IK in the pursuit of their farming activities. The study employed a mixed method approach (case study and cross sectional survey). It involved 230 respondents comprising 96 (41.7%) female and 134 (58.3%) males. The study found that many farmers possess an extensive indigenous knowledge on soil characteristics, cropping systems, land suitability for farming, preservation of planting materials, methods of crop planting, crop preservation after harvesting, plant pests, diseases, predators and their control and agro-biodiversity management around community surroundings. Moreover, 151 (65.7%) of the respondents reported that IK is sufficient for solving farming problems, 57 (24.8%) were not satisfied with existing IK in their communities, and 22 (9.6%) respondents did not have any opinion. Also, when asked to state their opinions on usefulness of IK in the management of agro-biodiversity, 212 (95.0%) said indigenous knowledge is useful and only 11 (5.0%) said it is not useful. It can therefore, be plausibly concluded that the communities know the benefit potentials of IK and indigenous agro-biodiversity knowledge for their survival. In view of the above, it is recommended that identification of IK types is important in determining and increasing understanding on what farmers know and how that knowledge can be located and used to add value to agricultural productivity. Agricultural development can be best achieved if researchers and extension officers are educated on the significance, complexity and usefulness of local knowledge.

Keywords: Traditional Ecological Knowledge; Indigenous Knowledge; agro-biodiversity knowledge; farming communities; farming practices

Introduction

Indigenous Knowledge (IK) is used interchangeably with many terminologies such as Traditional Ecological Knowledge (TEK), Traditional Knowledge (TK), Aboriginal knowledge (AK) and many others. It is knowledge that is tacit, orally communicated, experiential, unique and embedded in the heads, activities and practices of communities with long histories of close interaction with the natural environment across cultures and geographical spaces. IK is largely used by local communities to make decisions (Du Plessis, 2002; Ngulube, 2002; Ellen and Harris, 2000; World Bank, 1998). TEK describes aboriginal, indigenous, or other forms of traditional knowledge regarding sustainability of local resources. TEK refers to "a cumulative body of knowledge, belief, and practice, evolving by accumulation of traditional knowledge related to the environment and handed down through generations through traditional songs, stories and beliefs. It concerns the relationship of living beings (including human) with their traditional groups and with their environment (IPRN, 2016).

According to IPRN (2016), traditional ecological knowledge (TEK) is mainly of a practical nature, particularly in such fields as crop farming, animal husbandry, fisheries, health, horticulture and forestry. It is the basis for local decision-making in livestock keeping, crop farming, hunting and gathering, nutrition and food preparation, resource management, education and health as well as social, economic, and political organization. It is recognized as “the inextricable link between cultural and biological diversity”. Traditional knowledge on the other hand is described by Pierotti *et al*., (2000) as the knowledge, innovations and practices of indigenous and local communities around the world which is developed from past experiences gained over centuries and adapted to the local culture and environment. Traditional knowledge is transmitted orally from generation to generation and it is collectively owned by the members of a particular indigenous community taking the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and crop and animal husbandry practices including the development of plant species and animal breeds (Pierotti *et al*., 2000). According to Niamir (1990), local people can identify more plant varieties and animal species than formal science, probably due to the fact that they have had more time to search and find all the plants in their area. This cuts across most societies which their livelihood is dependent upon the natural resource base for survival.

Despite the role played by IK, production in low developed countries is low and studies attribute this to inadequate utilization of IK, inability to adapt to changing circumstances and lack of local innovations (Hart and Mouton, 2005; Magoro and Masoga, 2005). Moreover, farmers do not earn high income because their innovations and discoveries are considered mostly incremental, and because indigenous technologies are applied in isolation (Hart, 2007; Akiiki, 2006). Nonetheless, if properly harnessed, IK can be used to ensure that agricultural developments are viable within the local environment (Magoro and Masoga, 2005). Traditional ecological knowledge (TEK) in particular, is central to indigenous world views and practices and is one of the most important contributions that indigenous people can bring to conservation management partnerships (Wehi *et al.*, 2014).

Problem statement

The domination of globalization processes such as modernization of agriculture has impacted negatively on IK. For example, while modernization of agriculture may increase availability of food and the levels of food trade, it does not meet the basic agricultural, nutrition and livelihood needs of most small farmers (Gari, 2004 and Koda, 2003). Despite its overwhelming potential in improving agricultural productivity and livelihoods of local communities, indigenous knowledge harnessed by farmers is not accorded the same importance as conventional knowledge. Consequently, the knowledge possessed by farmers in most developing countries is not recognised as formal and reliable sources of knowledge (Kilongozi, Kengera and Leshongo, 2005). The transfer of IK from generation to generation is mostly done through oral tradition and demonstrations. Similarly IK is not equally shared due to power and cultural differences. Instead, IK is stored in the minds of people who may die with the knowledge they have accumulated over a long period of time (Ikoja-Odongo, 2006; Meyer, 2003). This paper thus aims at describing well the role played by IK of the farmers in Lindi and Mtwara regions and their overall perceptions on usefulness of IK in the pursuit of their farming activities.

Methodology

The study was carried out in Lindi (Nachingwea district), Mtwara (Masasi district). The objective of the study was to identify existing indigenous knowledge related to agro-biodiversity management among local communities and examine how local communities perceived the usefulness of the existing IK related to agro-biodiversity in meeting their farming requirements. The research employed a mixed research design, using cross-sectional design which involves collecting data at one point in time, utilizing a combination of activities, including an extensive literature review, consultations with experts and local communities to provide socio-economic oriented findings (Bryman 2004). A case study (small communities in villages) was drawn to enable description of features (indigenous agro-biodiversity knowledge and management practices) in detail (Bryman 2004). The study population included the following two categories of respondents: (i) Local communities – small holder farmers and village leaders; (ii) IK intermediaries (extension officers and forest officers).

A four-stage sampling was used to draw a sample for this study. Multi-stage sampling was adopted because the population is scattered over a wide geographical area and a survey was made within a limited time and financial resources. A non-probability, purposive sampling technique was used to select two districts, and 4 villages from the two districts for the study. The final sample consisted of 8 villages, 4 villages from each district. Respondents who were interviewed were selected using systematic random sampling. Their names were selected from the village government register of households. Purposive sampling was used to select other categories of respondents in the study, including key informants and participants for focus group discussions (FGD). 230 heads of households were interviewed using questionnaire. In addition two key informants were interviewed in each village. Between 8 and12 people participated in one FGD discussions in each village.

Results and discussions

Socio-economic characteristics of respondents

In terms of gender, the study involved 96 (41.7%) female and 134 (58.3%) males. Male were relatively many compared to female because in these communities in the South regions communities, this group was always found at home during the survey where female at that time were engaged in core household activities but are also restricted to talk to people from outside in presence of their husbands (Table 1).

Table 1: Sex of respondents N=230

Sex	Frequency	Percent
Female	96	41.7
Male	134	58.3
Total	230	100.0

Sex may influence ownership to land and hence the role of TEK in natural resources management. It also influences adoption depending on ownership of resources at the household level such as land and livestock, all of which are important in determining the role played by TEK and indigenous agro-biodiversity knowledge. Studies show that gender determines who does what in terms of collection of wild products (Kajembe *et al.*, 2000). Indigenous knowledge is unevenly distributed because it is closely tied to an activity and accessibility is determined by participation in related activities. Traditional healers, traditional birth attendants, farmers, livestock keepers and honey collectors for instance, access relevant local knowledge and acquire skills through active involvement in related activities, experimentation, adaptation and propagation of new ideas gained through experience (Koda, 2003). Both male and female participate in related activities differently. Thus, increase or decrease in participation by one sex in certain activities results in the observed differences.

Table 3: Distribution of respondents by age group N=230

Category	Frequency	Percentage
36-45 age group	64	28.2
27-35 age group	43	18.9
18-26 age group	14	2.2
Total	122	63

Source: Field survey 2012

Table 3 above shows that 64 (28.2%) of the respondents were in the 36 to 45 age group, 43 (18.9%) in the 27 to 35, age group and 14 (6.2%) in the 18 to 26 age group. The mean age of the respondents is 46.04 years. Therefore, 47% of the respondents are middle aged. Age has influence on knowledge of various things in a given place, and it is vital in explaining experiences and benefits of various TEK and indigenous agro-biodiversity knowledge practices that have been undertaken in the area for many years. In this study, the mean age of respondents was 46.90 years (Table 3), which means that most respondents were elderly. This could influence positively the perception of the importance of IK.

Table 4: Distribution of respondents by level of education N=230

Category	Frequency	Percentage
Primary education	193	83.9
Secondary education	6	2.6
No schooling	17	7.4
Informal education	9	3.9
Post-secondary education	5	2.2
Total		

Source: Field survey 2012

According to Table 4, a majority of the respondents 193 (83.9%) had primary school education, 6 (2.6%) had secondary education, 17 (7.4%) had no formal schooling (illiterate), 9 (3.9%) had informal schooling and 5 (2.2%) had post-secondary education.

Table 5: Highest education level by sex of respondent N=230

Category	Female		Male	
	Frequency	Percent	Frequency	Percent
Informal schooling	4	44.4	5	55.6
Primary education	78	40.4	115	59.6
Secondary education	2	33.3	4	66.7
Illiterate	3	52.9	8	47.1
Post-secondary	9	60.0	2	40.0

Source: Field survey, 2012

Level of education was cross tabulated with sex of respondents. The study results as indicated in Table 5 above shows that 3 (53%) of the female respondents have no formal education. 9 (60%) of females have post-secondary education compared to 2 (40%) of their male counterparts. By contrast, 115 (59.6%) of males have primary education compared to 78 (40.4%) of their female counterparts while 4 (66.7 %) of the males have secondary education compared to 2 (33.3%) their female counterparts. In terms of literacy levels that are the ability to read and write in Kiswahili language is high in the two districts surveyed. The study findings revealed that 193 (84%) of the respondents have primary education. Education is an important issue in development of livelihood strategies as it determines which livelihood activities a household is involved. Therefore, education is an enabling factor that influences households in the study area to engage in various livelihood activities and therefore in valuing IK. Similar arguments were put forward by Shalli (2003) in the Coastal region of Tanzania. He emphasized that the level of education has a remarkable bearing on sustainable management of natural resources. It was generally acknowledged that education is perceived as being among the factors that influence an individual’s perception on importance of IK. According to Mitinje *et al.*, (2007), education is normally considered as the key to improved opportunities for development and accessibility to information and services.

Respondents’ characteristics are important in determining how they facilitate or hinder the respondents’ ability to manage IK in relation to farming activities, agro-biodiversity management and effective Knowledge Management (KM). Both men and women have different knowledge about agro-biodiversity activities, organization of knowledge, and preserving and knowledge transfer (Niamir- Fuller, 1994). Gender is thus an important factor and influences KM processes in local communities. Indigenous knowledge is unevenly distributed because it is closely tied to an activity and accessibility is determined by participation in related activities. It has been reported by Koda (2003), that traditional healers, traditional birth attendants, farmers, livestock keepers and honey collectors for instance, access relevant local knowledge and acquire skills through active involvement in related activities, experimentation, adaptation and propagation of new ideas gained through experience.

All the interviewed respondents were engaged in farming activities and collection of wild products for their survival as shown in Table 6 below.

Table 6: Respondents by occupation N=230

Category	Frequency	Percent
Farming	230	100
Wild product collection	230	100

As indicated in Table 7 below, the proportion of females engaged in collecting wild products are fewer compared to their male counterparts except for firewood collection where 59 (93.7%) of female collect firewood compared to 67 (92.6%). Most heads of households interviewed in Nachingwea and Masasi were males (except in Nachingwea where female heads of households dominated). This implies that males are the main collectors and traders of wild products in the study areas. However, when it comes to high value products such as charcoal and bamboo, 16 (25.4%) and 17 (27.0%) of females are also engaged in charcoal and bamboo activities respectively just like their male counterparts 20 (27.4%) and 28 (38.4%) respectively.

Table 7: Wild products collection using indigenous knowledge by sex in Masasi and Nachingwea districts N=230

Product collected	Sex			
	Female		Male	
	Frequency	Percent	Frequency	Percent
Firewood	59	93.7	67	92.6
Poles	13	20.6	24	32.9
Plant medicine	0	0.0	7	9.6
Honey	1	1.6	7	9.6
Mushroom	4	6.3	16	22.2
Fruits	15	23.8	30	41.1
Vegetables	8	12.7	22	30.1
Wild animals	3	4.8	10	13.7
Charcoal	16	25.4	20	27.4
Bamboo	17	27.0	28	38.4

Source: Field survey, 2012

Occupation of respondents

All the respondents in this study are engaged in crop farming and gathering of wild products.

Crop and tree farming

Table 8: Major crops grown using indigenous knowledge by respondents in selected districts N=230

Category	Frequency	Percent
Maize	227	98.7
Rice	17	7.4
Pigeon peas	204	88.7
Sesame	35	15.2
Cashew nut	127	55.2
Cassava	146	63.5
Groundnuts	39	17.0

Source: Field survey, 2012

All the 230 respondents interviewed are involved in crop farming and gathering of wild products. Table 8 above shows that 227 (98.7%) of the respondents grow mostly maize, 204 (88.7%) grow pigeon peas, 146 (63.5%) grow cassava, 127 (55.2%) grow cashew nut, 39 (17%) grow groundnuts, 35 (15.2%) grow sesame and 17 (7.4%) grow paddy.

Table 9: Size of farm and farming experience of respondents N=230

Category	N	Minimum	Maximum	Mean
Size of the farm (acres)	229	1.00	55.00	7.7576
Experience in crop production (years)	227	1.00	60.00	23.5419

Source: Field survey, 2012

The average farm size cultivated is 7.76 acres. Most respondents had an average of 23.54 years of farming experience (Table 9).

Table 10: Tools used for cultivating and managing wild surroundings N=230

Category	Frequency	Percent
Hand hoe	227	99.6
Axe	198	92.5
Machete	170	98.8

Source: Field survey, 2012

As shown in Table 10 above major tools used to manage farms and wild surroundings are mainly hand hoes 227 (99.6%), axes 198 (92.5%) and machetes 170 (98.8%).This indicates that farmers rely on non-mechanized farming which predominantly uses local knowledge to earn a living.

Various types of indigenous knowledge related to agro-biodiversity management practices among local communities

The study sought to identify existing indigenous knowledge related to agro-biodiversity management among local communities. Data to address this objective were collected using semi-structured interviews, focus group discussions and key informant interviews. This objective was based on the assumption that the communities have an extensive base in IK which needs to be identified for Knowledge Management practices and sustainable agro-biodiversity activities to be effective. This section presents the results in relation to the identification of agro-biodiversity IK types and use of IK for agro-biodiversity management activities

Indigenous knowledge on selected farming practices

i. Indigenous knowledge on soil characteristics

Local communities possess a range of knowledge on soil types in their farms.

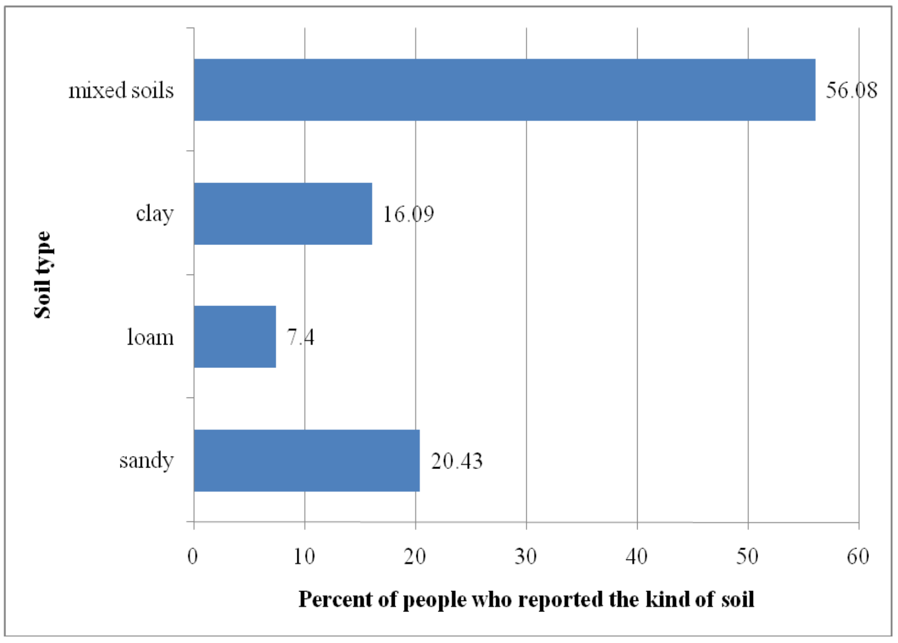

Figure 1: Indigenous knowledge on soil characteristics

Source: Field survey, 2012

In this study and as shown in Figure 1, 129 (56.08%) of the farmers indicated that their farms are rich in sandy, clay and loam soils. 47 (20.43%) of the respondents indicated that their farms are rich in sandy soils, 37 (16.09%) rich in clay soils and 17 (7.4%) said their farms were rich in loam soils. During Focus Group Discussions, it was revealed that local communities possess a wide range of indigenous knowledge on soil fertility (especially good and bad soil characteristics).

Table 11: Indigenous knowledge on good soils and technical equivalents

Local indicators	Technical equivalents
Black color	High organic matter content
Cracks during dry season	High clay content
Good crop performance	Adequate supply of growth factors
Presence/ vigorous growth of certain plants	Large supply of plant nutrients
Presence of plants in a dry environment	High water holding capacity (WHC)
Low frequency of watering	High infiltration rate and WHC
Abundance of earth worms	High biological activity, high organic matter content and neutral pH.

Source: Field survey, 2012

Table 11 above and Table 12 below show local knowledge indicators of good and bad soils. They also show their technical equivalents.

Table 12: Indigenous knowledge on indicators of bad soil and technical equivalents

Local indicators	Technical equivalents
Yellow and red color	Low soil fertility / low organic matter content
Compacted soils	Presence of cementing materials (Al, Fe2O3 heavy clays) and low biological activity
Stunted growth	Physical, chemical and biological limitation

Appearance of certain bad species of plants	Low fertility
Salt visible on surface	High pH, high osmotic pressure
Presence of rocks and stones	Shallow soils

Source: Field survey, 2012

ii. Indigenous knowledge on cropping systems

Respondents were asked to state types of crop systems they practice. According to Table 13 a majority of the respondents 224 (97.4%) indicated that they practice intercropping and 62 (27.0%) said they practice monocropping. Intercropping is practiced widely by local communities in Masasi and Nachingwea. In both districts, the dominant intercropped crops are mainly maize + pigeon peas and maize + cassava + pigeon peas as shown in Table 14 below.

Table 13: Indigenous knowledge on cropping systems practiced in the study area N=230

Category	Frequency	Percent
Intercropping	224	97.4
Monocropping	62	27.0

Source: Field survey, 2012

Table 14: Kinds of crops intercropped using indigenous knowledge N=230

Crops intercropped	Frequency	Percent
Maize + pigeon peas	49	21.3
Maize + cassava + pigeon peas	39	17.0
Maize + pigeon peas + groundnuts	5	2.2
Maize + pigeon peas + cashew nuts	4	1.7
Maize + pigeon peas + Sesame	3	1.3
Maize + pigeon peas +,cashew nuts + cowpeas	3	1.3

Source: Field survey, 2012; multiple responses were possible.

As indicated in Table 13 above the mono-cropping system was ranked second in terms of application in farming system by local communities and intercropping was ranked first. Respondents were asked to give reasons why they preferred intercropping. In response to this question, 54 (23.5%) indicated that they prefer intercropping due to land shortages, 54 (23.5%) said intercropping is easy to manage, 39 (17.0) attributed it to inadequate labor, 22 (9.6%) said lack of knowledge on other farming methods, 22 (9.6%), said intercropping maximizes production through diversification because when one crop fails other crops may perform better and 16 (7.0%) said in order to conserve soil fertility. Other reasons mentioned for practicing inter-cropping include: inherited culture 21(9.1%), lack of farming tools and lack of income 2 (0.8%) (Figure 2).

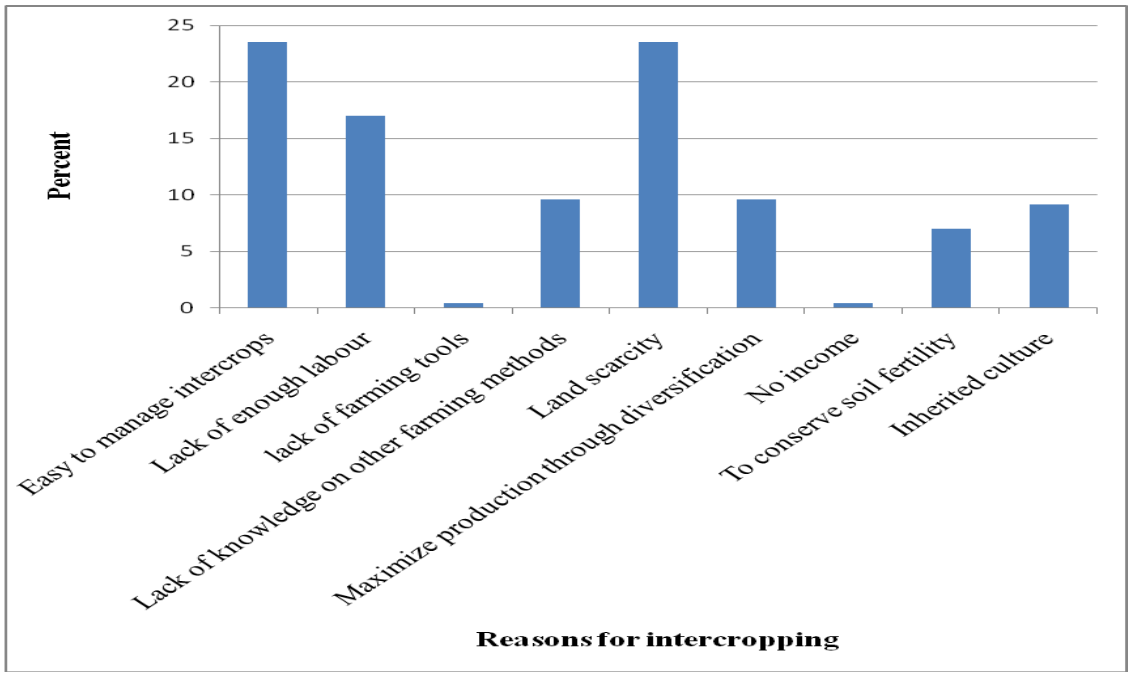

Figure 2: Reasons for intercropping

Source: Field survey, 2012

Respondents were asked to give reasons as to why they prefer mono-cropping. Responses are shown in Table 15 below.

Table 15: Reasons for monocropping N=230

Category	Frequency	Percent
Ability to handle monocropping	1	0.4
Depend on soil type	1	0.4
Does not practice monocropping	156	67.8
Easy weeding	1	0.4
Enough land	6	2.6
Increased harvest due to reduced competition	24	10.4
Is a cultural inheritance	2	0.9
It is hard and takes time to do intercropping	1	0.4
Lack of income	2	0.9
Lack of knowledge	1	0.4
Nature of crops grown	16	7.0
To avoid shade for other crops	18	7.8
To increase soil fertility	1	0.4

Source: Field survey, 2012

Table 15 above shows that 24 (10.4%) cited increased harvest due to reduced competition among plants as a major reason, 18 (7.8%) said to avoid shade for other crops and 16 (7.0%), said nature of crops grown is a major decisive factor. Respondents were asked to mention crops which are monocropped. Responses are shown in Table 16 below.

Table 16: Kinds of crops grown under monocropping system N=230

Category	Frequency	Percent
Cashew nut	27	11.7
Maize	11	4.8
Pigeon peas	14	6.1
Cassava	7	3.0
Sesame	7	3.0
Paddy	14	6.1
Groundnut	10	4.3
Cow peas	2	0.9
Millet/sorghum	7	3.0
Tomato	2	0.9

Source: Field survey, 2012

iii. Indigenous knowledge on land suitability for farming

Respondents were asked to state the criteria they use to select land before cultivation. The results are presented in Table 17.

Table 17: Criteria used to select a piece of land suitable for planting crops N=230

Criteria	Frequency	Percent
Plots suitability for specific crops	134	58.3
Fertile lands	126	54.8
Type of soil	109	47.4
Water holding capacity	29	12.6
Weather conditions (rain season)	33	14.3

Source: Field survey, 2012

Findings revealed that over half 134 (58.3%) of the respondents use plot suitability for specific crops, 126 (54.8%) look at fertile land and 109 (47.4%) use the type of soil to decide which crops to grow. Only 29 (12.6%) use water holding capacity and 33 (14.3%) look at occurrence of rains as criteria to determine when crops should be planted (Table 17).

iv. Indigenous knowledge on preservation of planting materials

Centuries of practical experience have given local farmers a unique decision-making ability and knowledge about conservation and storage of seeds. Methods for preserving seeds in the communities were grouped in the following categories:

- Exogenous techniques: conventional facilities which include use of non-traditional storage facilities such as polythene bags, drums, plastic containers and tins for preserving seeds; conventional inputs include use of synthetic chemicals such as pesticides to prevent, destroy, repel or mitigate pests in the planting materials;

- Indigenous techniques: traditional facilities which include use of facilities that are locally made for preserving seeds such as clay pots, roof tops and granaries located outside or within farmers houses; cultural inputs and practices: these include use of locally available inputs (such as kitchen ash, anthill soil), and cultural practices (such as some crops were left in the soil, and selected cobs are hung over a tree or over a wood cooking stove to ensure smoke penetrates maize cobs.

Local communities were asked to mention methods they prefer to store seeds for the next growing season.

Table 18: Methods preferred for storing seeds N=226

Method	Frequency	Percent
Indigenous	132	58.4
Exogenous	94	41.6
Total	226	100.0

Source: Field survey, 2012

Findings as shown in Table 18, revealed that 132 (58.4%) prefer to use indigenous techniques. Only 94 (41.6%) prefer exogenous techniques (Table 18). During Focus Group Discussions and Key Informant Interviews, it was revealed that many households in the study area do not have cash to access improved seeds varieties. Moreover, a few vendors in the villages bring agro-inputs occasionally. Some of the agro-inputs supplied are pesticides and packaging materials (polythene bags).

When asked to mention methods they use to store maize, pigeon peas and cassava seeds, the farmers mentioned a wide variety of methods used as shown in Table 19 below.

Table 19: Methods used to store maize and pigeon peas after harvesting N=230

	Methods of storage (%)								
Crop	**Hung on racks outside the house**	**Hung over smoke in the kitchen**	**Store in a granary outside the house**	**In polythene bags**	**Store in plolythene bags and mix with insecticide**	**On the rooftops**	**Left to dry in field**	**Mixed with ash in polythene bags**	**Pat in day pot**
Maize	6.1	8.3	19.1	36.1	11.3	0.4	0.4	1.3	3
Pigeon peas	0	3	0	40.4	7.4	0	0	2.2	2.2

-While conventional inputs are important for preserving seeds in the surveyed regions, findings of this study further revealed that farmers have extensive knowledge on cultural practices and traditional facilities which are used for preserving seeds.

The methods used to preserve each crop vary. For example 112 (36.1%) of the respondents indicated that they store maize seeds in polythene bags, 19 (19.1%) said they store seeds in granary outside the house. Other methods include drying crops on roof tops, storing seeds in clay pots, plastic containers and hanging them on wooden racks outside the house (Table 19). 115 (40.4%) said they store pigeon peas in polythene bags , drums, plastic containers, clay pots or simply hang seeds over smoke (Table 19).

Respondents were asked to mention methods they use to store cassava cuttings. Responses are shown in Table 20.

Table 20: Methods used to store cassava cuttings

Method	Frequency	Percent
In wet polythene bags	37	16.1
Left in soil in farm	57	24.8
Do not store	136	59.1
Total	230	100.0

Source: Field survey, 2012

Table 20 shows that 57 (24.1%) of the farmers leave some of the cassava plants in the field for planting during the subsequent planting season. 37 (16.1%) said they store cassava cuttings in polythene bags which they water occasionally until they are ready for planting (Table 20). The storage method for storing cassava is unique because of the nature of the plant.

v. Indigenous knowledge on methods of crop planting

Respondents were asked to indicate Indigenous Knowledge on methods of crop planting. **R**esults are indicated in Table 21.

Table 21: Planting/sowing patterns for three major crops in the study area N=230

Crop	Planting/sowing pattern					
	Use of ridges		Rows without proper spacing		Random	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Maize	43	18.7	142	61.7	45	19.5
Pigeon peas	29	12.6	115	50.0	32	13.9
Cassava	17	7.4	80	34.7	26	11.3

Source: Field survey, 2012

Interviews with maize, pigeon peas and cassava growers revealed three major crop planting/sowing methods. In this study 43 (18.7%) said they plant maize using ridges, and 29 (12.6%) plant pigeon peas on ridges. However, 142 (61.7 %) plant maize on rows but with no proper spacing and 115 (50%) also plant pigeon peas on rows with no proper spacing. However, 45 (19.5) plant maize randomly and 32 (13.9) plant pigeon peas randomly. Similarly, 17 (7.4%),use ridges to plant cassava and 80 (34.7%) plant cassava in rows without proper spacing while 26 (11.3%) plant cassava randomly. The use of rows on flat land without proper spacing, random method and use of ridges are the methods used to plant crops but overall, most farmers prefer rows followed by random planting/sowing and use of ridges Table 21).

vi. Indigenous knowledge on crop preservation after harvesting

Farmers were asked to state methods they use to preserve crops after harvesting. Results are presented in Figure 3.

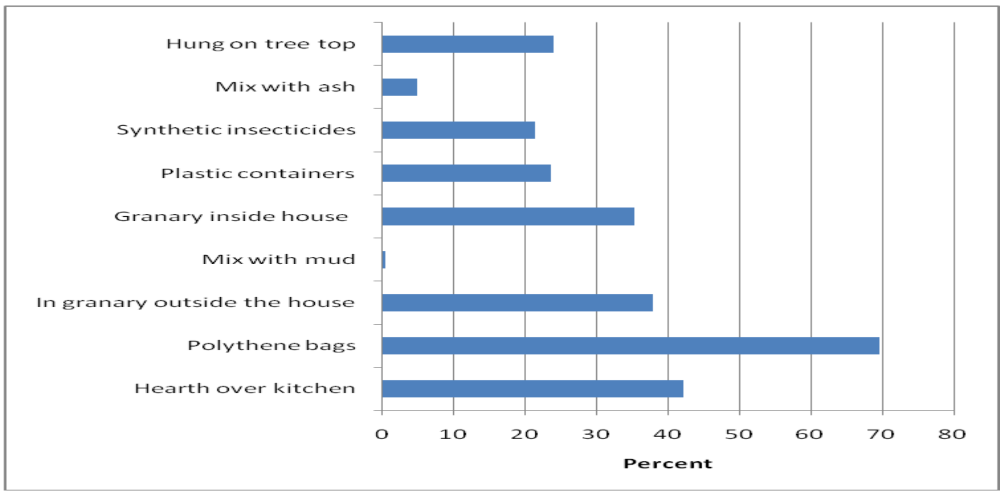

Figure 3: Crop preservation after harvesting

Source: Field survey, 2012

Respondents mentioned a wide range of both conventional and indigenous crop preservation methods. For example, 160 (69.6) of the respondents mentioned polythene bags, 97 (42.2%) mentioned hanging over the kitchen hearth, 87 (37.8%) mentioned granary outside the house, 81 (35.2%) said granary inside the house, 55 (23.9%) said they hang crops on trees, 54 (23.5%) said they use plastic containers, 49 (21.3%) use synthetic pesticides and 11 (4.8%) said they add ash to seeds. Only 1 (0.4%) farmer said mixes crops with mud (Figure 3).

vii. Indigenous knowledge on plant pests, diseases, predators and their control

Respondents were asked to indicate methods they use to diagnose and control plant diseases and pests. Responses are shown in Table 22 below.

The findings revealed that farmers have a broad base of knowledge on the diagnosis of plant diseases. Many farmers identified plant diseases/pest using symptoms rather than the name of the diseases/pests. As shown in Table 22 for each crop the symptoms varied. For maize 110 (48.8%), pigeon peas 79 (34.3%), cassava 55 (23.9%) and cashew 71 (30.8%) farmers used symptoms to identify crop diseases. For example, when cross checked with key informants (extension staffs), it was revealed that the powdery substance mentioned for cashew disease is powdery mildew (a fungal disease that attacks cashew trees). Similarly, the powdery substance identified for pigeon peas is powdery mildew. What this implies is that farmers use indigenous knowledge and experience to identify crop diseases/pests.

Table 22: Indigenous knowledge on crop diseases and pest symptoms N=230

Crop	Symptom	Frequency	Percent
Maize			
	Bored stems/leaves	28	12.2
	Withering	50	21.7
	Yellowing	13	6.3
	Maize streaks	4	2.0
	Fungal attack	9	4.0
	Empty cobs, bored leaves, brown leaves	6	2.6
	Do not know the symptoms	120	52.2
Pigeon peas			
	Withering	35	15.7
	Powdery substance	5	2.1
	Stunting	3	1.3
	Yellowing	2	0.9
	Dry leaves, empty pods, flower fall	34	14.3
	Do not know the symptoms	151	65.7
Cassava			
	Root rot	23	10.0
	Bored roots	11	4.8
	Cassava mosaic	5	2.2
	Powdery substance	6	2.6
	Withering	8	3.5
	Wilting	1	0.4
	Brown stem and leaves	1	0.4
	Do not know the symptoms	175	76.1
Cashew nut			
	Powdery substance	39	17.0
	Withering	20	8.7
	Bored leaves	7	3.0
	Yellowing	4	1.7
	Rotting	1	0.4

Do not know the symptoms	154	67.0

Source: Field survey, 2012

In terms of diseases/pests control, and as shown in Table 23 below findings revealed that farmers use chemical inputs to control plant diseases/pests. In this study, 84 (36.6%) of the respondents said they use synthetic pesticides and 146 (63.4%) did not indicate any method. Wild animals invading farms are controlled mainly using cultural methods as listed in Table 23 below. Many farmers do not use any measures to control plant diseases/pest probably due to lack of access to knowledge and inputs for diseases/pest control.

Table 23: Control of diseases, pests and wild animals N=230

Element	Control method	Frequency	Percent
Diseases/pests			
	Use of synthetic pesticides	84	36.6
	No control measure	146	63.4
Wild animals (predators)			
	Use of traps	19	8.3
	Use of poisons	30	10.9
	Use of poisons and traps	27	13.1
	Use of scarecrow sculptures	8	11.3
	Hunting	9	3.9
	Early crop planting	2	0.9
	Hunting, scaring, patrols and fire	23	10.7
	No control measure	112	48.7

Source: Field survey, 2012

viii. **Indigenous knowledge on agro-biodiversity management around community surroundings**

Respondents were asked to state the methods they use to protect their surroundings.

Table 24: IK used to protect agro-biodiversity surrounding local communities N=230

Method	Frequency	Percent
Uses fire to control pests	40	17.4
Uses fallow to allow plant regeneration	22	9.6
Makes buffer zones in the general land	20	8.7
Observes village bylaws for use of wild surroundings	10	4.3
Makes patrols to protect wild surroundings	25	10.9

Source: Field survey, 2012

Findings as shown in Table 24 above revealed that 40 (17.4%) use fire and 25 (10.9%) said they patrol the surrounding areas. Other methods they use include fallow to allow plant regeneration, buffer zones to demarcate areas allowed for public use and protected areas and observation of village bylaws in land usage.

Usefulness of IK in managing agro-biodiversity

i. **The perceived usefulness of indigenous knowledge in managing agro-biodiversity**

The respondents were asked if the existing agricultural IK in the local community is sufficient to meet their farming requirements. In response to this question, 151 (65.7%) of the respondents reported that IK is sufficient for solving farming problems (Table 25), 57 (24.8%) were not satisfied with existing IK in their communities, and 22 (9.6%) respondents did not have any opinion.

Table 25: If the existing agricultural IK in the local community is sufficient to meet farming requirements

Response	Frequency	Percent
Yes	151	65.7
No	57	24.8
Don't know	22	9.6
Total	230	100.0

Source: Field survey, 2012

Farmers who indicated that IK is not sufficient to solve their farming activities gave the following reasons which are arranged in descending order of importance:

- Low agricultural production: The respondents reported that they experienced low agricultural production due to the use of IK. Thus, farmers suggested a need to have access to external knowledge in order to improve their knowledge base and agricultural productivity;

- Unreliable weather especially rainfall. They stated that local landraces do not perform well when rains come late and or diminish earlier in the season;

- Lack of extension services to train farmers on how to integrate exogenous knowledge and technologies with indigenous knowledge and technologies.

Hence their IK remained ineffective in solving some problems such as animal and plant diseases, soil fertility decline, marketing information, and sources of credits. When asked to state their opinions on usefulness of IK in the management of agro-biodiversity, 212 (95.0%) said Indigenous knowledge is useful and only 11 (5.0%) said it is not useful (Table 26).

Table 26: Usefulness of indigenous knowledge in management of agro-biodiversity

Perception	Frequency	Percent
Very useful	73	32.7
Useful	89	39.9
Somehow useful	50	22.4
Not useful	11	4.9
Total	223	100.0

Source: Field survey, 2012

ii. Modeling the factors influencing perception on usefulness of IK

In addition, binary logistic regression model was conducted to determine perceptions on the usefulness (importance) of indigenous knowledge in meeting their farming requirements. Results of the analysis are presented in Tables 27 and 28.

Binary Logistic regression model:

$$Logit(Y) = \ln\left(\frac{p}{1-p}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon_i$$

Where: p = probability of the event,

α = Y intercept,

β_i = regression coefficients,

X_s = a set of predictors.

Hypothesis 1: wanted to find out if respondents' characteristics influence perceptions regarding the usefulness (importance) of IK in meeting farming requirements.

Test statistic: *Binary Logistic regression*

H_o : $\beta_1 = \beta 1 = \quad ... = \beta_n = 0$

H_1 : At least one of $\beta_s \neq 0$

Table 27: Factors influencing the perceived usefulness of IK in meeting farming requirements N=230

Variables	B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
							Lower	Upper
Sex	-.037	.291	.016	1	.900	.964	.545	1.705
Age	-.012	.010	1.282	1	.258	.989	.969	1.008
Literacy status	-.941	.655	2.061	1	.151	.390	.108	1.410
Total income	.000	.000	.260	1	.610	1.000	1.000	1.000
Constant	2.115	.803	6.937	1	.008	8.289		

Table 28: Test statistics for Binary Logistic Regression

Tests	**χ^2**	**df**	**P-value**
Model evaluation (overall):			
Likelihood ratio test (Omnibus Tests of Model Coefficients)	6.093	4	0.192
Goodness-of-fit test:			
Hosmer and Lemeshow test	6.378	8	0.605
Cox & Snell R^2 = 0.026			
Negelkerke R^2 = 0.0.037			
Valid Sample size = 230			

The model fits well as indicated by Hosmer Lemeshow Test being above 0.05 (p=0.605) (Table 6). Results from the binary logistic equation indicate that the variables influencing the perceived usefulness (importance) of IK as meeting farming requirements contributed by 2.6% and 3.7% as explained by Cox and Snell R square and Nagelkerke R square values above.

Table 5 shows that Wald statistics are non-zero values, which implies that there is association between the dependent and independent variables. According to Norusis (1990) and Powers and Xie (2000), the non-zero Wald statistic values indicate the presence of relationships between the dependent and explanatory variables. Thus, on the basis of the results of this study the null hypothesis was rejected in favour of the alternative hypothesis that socio-economic factors influence the perception on usefulness of IK in meeting farming requirements in the studied communities. However, none of the factors had a statistically significant influence at 5% level of significance.

Policy implications

Research findings from this study are vital in helping to inform policy makers at different levels on potential role of indigenous agro-biodiversity knowledge in improving livelihoods of farmers, management and improvement of land use planning process in Masasi and Nachingwea districts. Also, the findings help to bridge the gap between scientific conservation methods and indigenous conservation practices of local farmer communities. The study is important as a generator of knowledge that can be incorporated into Education Curricula at different study levels for sustainable resource management in Tanzania and elsewhere as may be applicable.

Conclusions and recommendations

Local communities possess a broad base of IK which has proved to be valuable over centuries and respond well in case sources are scarce in their communities. Usage of indigenous knowledge and techniques to improve soil fertility, acquisition of planting materials, cropping systems, and crop planting systems, weed control, and control of predators is a common phenomenon in local communities (farming communities) as opposed to conventional inputs. It can therefore be plausibly concluded that the communities know the benefit potentials of indigenous agro-biodiversity knowledge for their survival. In view of the above, it is recommended that identification of IK types is important by different actors (government and private sector) in determining and increasing understanding on what farmers know and how that knowledge can be located and used to add value to agricultural productivity. Agricultural development can be best achieved if researchers and extension officers are educated on the significance, complexity and usefulness of local knowledge.

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